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TITANIUM [ADVANCE RELEASE]

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TITANIUM

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Excluding the United States, world production of titanium dioxide (TiO_2) contained in titanium mineral concentrates increased by 8% compared with that of 2006. The industry continued developing mine capacity for heavy-mineral sands, with many active projects around the world. U.S. consumption of titanium mineral concentrates increased moderately compared with that in 2006. The United States was heavily reliant on imports of titanium mineral concentrates from Australia, Canada, and South Africa.

In 2007, global TiO_2 pigment production capacity was estimated to be 4.9 million metric tons (Mt), a slight increase compared with that in 2007. According to U.S. Geological Survey (USGS) survey data, domestic production of TiO_2 pigment increased by 5% compared with that of 2006.

Consumption of titanium used in titanium metal and steel production continued to increase because of numerous orders for commercial aircraft, military hardware, and industrial equipment. U.S. and foreign titanium sponge producers were increasing production and adding new capacity. In 2007, domestic production of titanium ingot increased by 11% and mill product production increased by 6% compared with production in 2006.

Legislation and Government Programs

The Defense Advanced Research Projects Agency (DARPA) continued to fund work on its Titanium Initiative whose objective is to develop revolutionary processes for the low-cost extraction of titanium metal from oxide ores. DARPA efforts were aimed at producing high-quality titanium at target costs of less than $4 per pound. In 2007, this initiative was moving from the feasibility stage to a prototype operation (Defense Advanced Research Projects Agency, 2007, p. 38).

Production

Mineral Concentrates.—Titanium mineral concentrates of economic importance include ilmenite, leucoxene, rutile, synthetic rutile, and titaniferous slag. Mining of titanium minerals is usually performed using surface methods. Dredging and dry mining techniques are used for the recovery of heavy minerals. Gravity spirals are used to separate the heavy-mineral suite, while magnetic and high-tension separation circuits are used to separate the heavy-mineral constituents. Ilmenite is often processed to produce a synthetic rutile or titaniferous slag. Although numerous technologies are used to produce synthetic rutile, nearly all are based on either selective leaching or thermal reduction of iron and other impurities in ilmenite. Titaniferous slag with a TiO_2 content of 75% to 95% is produced commercially using pyrometallurgical processes.

U.S. mineral concentrate producers were DuPont Titanium Technologies [a subsidiary of E.I. du Pont de Nemours and Co. (DuPont)] and Iluka Resources, Inc. (a subsidiary of Iluka Resources Ltd.). DuPont's mining operations near Starke, FL, produced a mixed product containing ilmenite, leucoxene, and rutile that was used as a feedstock in DuPont's TiO_2 pigment plants. In 2007, Iluka produced titanium mineral concentrates from its heavy-mineral sand operations at Green Cove Springs, FL; Lulaton, GA; and Stony Creek, VA. Although Iluka ceased mining in Florida and Georgia, the Green Cove Springs operation continued to process stockpiled tailings. Iluka's Stony Creek operation produced ilmenite concentrate using dry mining techniques. In December, Iluka's board of directors approved the development of the Brink deposit to support the continued operation of its Stony Creek mining operations. The Brink deposit is about 48 kilometers south of the Stony Creek mining operations. The development of the Brink deposit was expected to extend the economic life of the Virginia operations from 2012 to 2014 (Iluka Resources Ltd., 2007).

Metal.—Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), which is reduced with magnesium (Kroll process) or sodium (Hunter process) to form a commercially pure form of titanium metal. As the metal is formed, it has a porous appearance and is referred to as sponge. Titanium ingot is produced by melting titanium sponge or scrap or a combination of both, usually with various other alloying elements, such as aluminum and vanadium. Electron beam (EB), plasma arc melt (PAM), scull, and vacuum-arc remelting (VAR) are the commercial methods used to produce ingot. Titanium mill products are produced from the drawing, forging, and rolling of titanium ingot or slab into products of various sizes and shapes. These mill products include billet, pipe and tube, plate, rod and bar, sheet, strip, and wire. Titanium castings are produced by investment casting and rammed graphite mold casting. Ferrotitanium is usually produced by induction melting of titanium scrap with iron or steel, but is also produced through the aluminothermic reduction of ilmenite. The two standard grades of ferrotitanium that are normally produced contain 40% and 70% titanium.

U.S. producers of titanium sponge in 2007 were Allegheny Technologies Inc. (ATI), Honeywell Electronic Materials Inc., and Titanium Metals Corp. (Timet). ATI's Albany, OR, plant and Titanium Metals Corp.'s Henderson, NV, plant produced titanium sponge using the Kroll process. Honeywell Electronic Materials' plant in Salt Lake City, UT, produced titanium sponge using the Hunter process and supported the company's production of electronic-grade titanium. Data on domestic production of titanium sponge are withheld to avoid disclosing company proprietary data (table 2).

Capacity at ATI's sponge plant was increased to 7,260 metric tons per year (t/yr) from 3,630 t/yr, and was expected to reach 9,980 t/yr by the second half of 2008. ATI was proceeding with construction of a new 10,900-t/yr titanium sponge plant adjacent to U.S. Magnesium LLC's magnesium plant in Rowley, UT. The new plant was designed using the Kroll process and was expected to begin production in 2008. ATI also was increasing ingot capacity at its Richland, WA, and Bakers, NC, facilities with new EB, PAM, and VAR furnaces (Allegheny Technologies, Inc., 2008, p. 8).

RTI International Metals Inc. announced plans to construct a 9,070-t/yr sponge plant in Hamilton, MS. The plant was scheduled to be operational in 2010 and was expected to help support a long-term mill product supply agreement between RTI and Airbus S.A.S. The new plant was sited proximate to Tronox Inc.'s Hamilton TiO_2 pigment plant, which was expected to supply $TiCl_4$ needed for titanium metal production. RTI also planned to increase its ingot, forging, scrap processing, and mill product capacities by 2010. The expansions were planned for RTI's Canton, OH; Houston, TX; Niles, OH; and Montreal, Quebec, Canada, operations (RTI International Metals Inc., 2008, p. 11).

Timet increased sponge capacity at its plant to 12,600 t/yr from 8,600 t/yr. Plans to construct a new sponge facility were postponed following the formation of supply agreements for 2010 through 2024 with Toho Titanium Co., Ltd., Chigasaki, Japan. Timet was expanding its ingot production capacity with a new EB furnace scheduled to be completed in early 2008, an additional EB furnace scheduled for completion in late 2009, and several new VAR furnaces to be completed by mid-2008. These additions were expected to double Timet's EB melt capacity and increase its VAR melt capacity by approximately one-third (Titanium Metals Corp, 2008, p. 20-21).

Perryman Co. added EB and VAR ingot capacity to its Houston, PA, mill. Approximately 1,360 t/yr of ingot capacity was added to enable Perryman to recycle home scrap (Purchasing, 2007).

In 2007, production of titanium metal products continued to rise to record levels. U.S. production of ingot rose to a record 59,200 metric tons (t), an 11% increase compared with that of 2006. Production of mill products increased by 6% compared with that of 2006 (table 3). U.S. producers of ferrotitanium were RTI Alloys, Canton, OH, and Global Titanium Inc., Detroit, MI. Data on production of ferrotitanium were not available.

TiO_2 Pigment.—TiO_2 pigment is produced from titanium mineral concentrates by either the chloride process or the sulfate process. In the chloride process, rutile is converted to $TiCl_4$ by chlorination in the presence of petroleum coke. $TiCl_4$ is oxidized with air or oxygen at about 1,000° C, and the resulting TiO_2 is calcined to remove residual chlorine and any hydrochloric acid that may have formed in the reaction. Aluminum chloride is added to the $TiCl_4$ to assure that virtually all the titanium is oxidized into the rutile crystal structure. In the sulfate process, ilmenite or titanium slag is reacted with sulfuric acid. Titanium hydroxide is then precipitated by hydrolysis, filtered, and calcined. Although either process may be used to produce pigment, the decision to use one process instead of the other is based on numerous factors, including raw material availability, freight, and waste disposal costs. In finishing operations, the crude form of the pigment is milled to produce a controlled distribution of particle size and surface treated or coated to improve its functional behavior in different media. Some typical surface treatments include alumina, organic compounds, and silica.

TiO_2 pigment produced by either process is categorized by crystal form as either anatase or rutile. Rutile pigment is less reactive with the binders in paint when exposed to sunlight than is the anatase pigment and is preferred for use in outdoor paints. Anatase pigment has a bluer tone than rutile, is somewhat softer, and is used mainly in indoor paints and in paper manufacturing. Depending on the manner in which it is produced and subsequently finished, TiO_2 pigment can exhibit a range of functional properties, including dispersion, durability, opacity, and tinting.

U.S. production of TiO_2 pigment was 1.44 Mt in 2007, a 5% increase compared with that in 2006 (table 5). U.S. producers of TiO_2 pigment by the chloride process were DuPont, Louisiana Pigment Co. L.P. (a joint venture of NL Industries, Inc. and Huntsman Corp.), Millennium Inorganic Chemicals Inc., and Tronox Inc. (table 4). TOR Minerals International, Inc. produced a buff TiO_2 pigment from finely ground synthetic rutile.

Consumption

Mineral Concentrates.—On a gross weight basis, 96% of the domestic consumption of titanium mineral concentrates was used to produce TiO_2 pigment. The remaining 4% was used to produce miscellaneous other products, including fluxes, metal, and welding rod coatings. Based on TiO_2 content, domestic consumption of titanium mineral concentrates was 1.6 Mt, a 4% increase compared with that of 2006 (table 6). Consumption data for titanium concentrates were estimated by the USGS owing to insufficient response by industry to the voluntary survey for consumption data.

Metal.—Titanium metal alloys are used for their high strength-to-weight ratio and corrosion resistance. Because of the increased supply of titanium sponge, consumption of titanium sponge increased, while scrap consumption decreased compared with that of 2006 (table 3). Scrap supplied a calculated 41% of ingot feedstock. Because of increased demand from aerospace and industrial markets, domestic shipments of titanium metal mill products increased by 10%. Estimated U.S. mill product usage by application was as follows: aerospace, 77%, and other, 23%. Other uses included those in the consumer goods, marine, medical, oil and gas, pulp and paper, and specialty chemical industries.

A significant quantity of titanium in the form of ferrotitanium, scrap, and sponge is consumed in the steel and nonferrous alloy industries. In the steel industry, titanium is used for deoxidation, grain-size control, and controlling and stabilizing carbon and nitrogen content. Titanium-intensive steels include interstitial-free, stainless, and high-strength low-alloy steels. Reported domestic consumption of titanium products in steel and other alloys was 13,200 t, a 15% increase compared with that of 2006 (table 7).

TiO_2 Pigment.—In the United States, consumption of TiO_2 pigment decreased moderately compared with that of 2006 (table 5). The leading uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States, were paint and coatings (59%), plastics and rubber (24%), and paper (12%) (table 8). Other uses (5%) included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Stocks

Insufficient data were available to determine yearend consumer inventories of titanium mineral concentrates and TiO_2 pigment producer stocks. Increased production levels worldwide and the delays in aircraft production improved the availability of most metal products. Stocks of scrap and ingot increased significantly. After rising significantly in 2006, industry stocks of sponge decreased by 5% compared with those of 2006 (table 3).

Prices

Titanium mineral concentrate prices are listed in table 9. Prices for bulk ilmenite were unchanged, while those for rutile concentrates were higher compared with prices in 2006. Published prices for titanium slag were not available. Based on U.S. Customs Service data, the yearend unit value of slag imports ranged from $418 to $457 per metric ton in 2007 compared with $402 to $454 per ton in 2006.

The U.S. Department of Labor, Bureau of Labor Statistics (BLS), yearend producer price index (PPI) for TiO_2 pigment decreased slightly compared with that of 2006. The monthly PPI started the year at a peak of 166, hit a low of 160 in November, and then rose to 162 by yearend (U.S. Department of Labor, Bureau of Labor Statistics, 2008).

Delays in large aircraft programs and increased supply from new production capacity caused prices of titanium metal products to fall. The BLS PPI for titanium mill products rose to a high of 311 in May and declined to a low of 277 by yearend.

Foreign Trade

Mineral Concentrates.—Imports of titanium mineral concentrates include ilmenite, rutile, synthetic rutile, and titaniferous slag. The United States is heavily reliant on imports of titanium mineral concentrates because domestic demand for titanium minerals greatly exceeds domestic production. In 2007, the TiO_2 content of imports was estimated to be 1.22 Mt, primarily in the form of titaniferous slag (52%) and natural rutile (29%). Australia and South Africa were the leading import sources. In 2007, the combined value for all forms of titanium concentrate imports increased by 16% to $530 million (table 11). Imports of titaniferous iron ore from Canada, classified as ilmenite by the U.S. Census Bureau, almost ceased compared with those in 2006. Exports of titanium concentrates were minor relative to imports (tables 10 and 11).

Metal.—Imports of titanium metal are primarily in the form of unwrought titanium and scrap. Kazakhstan (53%), Japan (32%), and China (9%) were the leading sources of imported titanium sponge, while the United Kingdom (22%), Japan (18%), France (14%), and Germany (12%) were the leading sources of imported scrap. The leading import sources of titanium ingot were Russia (58%) and Germany (39%). The expanding use of powder metallurgy to produce fabricated components caused imports of titanium powder to increase 62% compared with those of 2006. China (88%) was the major source of titanium powder. As the availability of domestic titanium ingot increased, imports of other unwrought forms of titanium decreased by 93% compared with those of 2006.

Imports of titanium wrought products and castings were primarily in the form of plate, sheet, strip, and foil (46%); bar, rod, profiles, and wire (24%); and billets (14%). Russia (62%), China (17%), and Japan (7%) were the leading import sources of wrought products and castings. Imports of wrought products and castings were unchanged compared with those of 2006. Exports of wrought products and castings increased by 17%.

Imports of ferrotitanium and ferrosilicon titanium, primarily used in the iron and steel industry, were 7,620 t, an 8% increase compared with those of 2006. The leading import sources were Russia (49%), Canada (16%), and the United Kingdom (13%). Exports of ferrotitanium and ferrosilicon titanium were 2,120 t, a 9% decrease compared with those of 2006.

TiO_2 Pigment.—The United States continued to be a net exporter of TiO_2 pigment. In 2007, exports exceeded imports by a ratio of 3 to 1. Exports of TiO_2 pigment were 682,000 t, a 17% increase compared with those of 2006. About 83% of exports was in the form of finished pigment with more than 80% TiO_2 content.

During 2007, 221,000 t of TiO_2 pigment was imported, a 23% decrease compared with that in 2006 (table 13). The leading import sources of TiO_2 pigment were Canada (38%), China (13%), Germany (6%), and Finland (6%). Pigment imports were primarily in the form of pigment with more than 80% TiO_2.

World Review

Australia.—Austpac Resources N.L. began construction of a 3,000-t/yr synthetic rutile demonstration plant in New Castle, New South Wales, based on the company's Enhanced Roasting and Magnetic Separation (ERMS) and Enhanced Acid Regeneration System (EARS) technologies. ERMS is a roasting process that magnetizes ilmenite and makes it amenable to leaching in hydrochloric acid. Magnetized ilmenite is then separated from deleterious minerals such as chromite. EARS is a process to regenerate hydrochloric acid from waste iron chloride liquors produced by leaching ilmenite. An important coproduct generated by the EARS process is salable iron oxide. A 60,000-t/yr synthetic rutile plant was planned for construction in 2008 (Austpac Resources N.L., 2008).

Bemax Resources Ltd. completed mining at its Ludlow and Tutunup South Mines in Western Australia. The company expected to continue mining at the Ginkgo Mine in eastern Australia's Murray Basin in 2008 and begin mining at the Gwindinup Mine in the first quarter of 2008. At yearend 2007, Bemax reported reserves of 11.1 Mt averaging 3.7% heavy minerals in the Murray Basin and 1.2 Mt averaging 11.8% heavy minerals in Western Australia. Bemax expected to raise its

heavy-mineral production to more than 650,000 t/yr beginning in the second quarter of 2008 (Bemax Resources Ltd., 2008, p. 7–21).

Iluka continued its exploration and developments in the Perth Basin, Murray Basin (Victoria and New South Wales), and Eucla Basin (South Australia). In the Murray Basin, Victoria, Iluka commissioned its Hamilton mineral separation plant. The Hamilton plant was supplied with heavy-mineral concentrate from the recently opened Douglas Mine. In the second stage of the Murray Basin project, Iluka expected to increase production to more than 300,000 t/yr from about 190,000 t in 2007 through the development of the Kulwin deposit. At yearend, Iluka was seeking regulatory approval to begin mine construction at the Jacinth-Ambrosia project in South Australia (Iluka Resources Ltd., 2008, p. 2).

Gunson Resources Ltd. signed a memorandum of understanding with China Triumph International Engineering Co., Ltd. to develop a mine at the Coburn deposit in Western Australia and build a minerals separation plant in China. The understanding included an offtake agreement for more than one-half of the annual zircon production from Coburn. Construction was expected to begin in 2008 with a design for about 130,000 t/yr of heavy-mineral concentrate (Gunson Resources Ltd., 2007, p. 9–11).

The Tiwest joint-venture partners Tronox Inc. and Exxaro Resources Ltd. (formerly Kumba Resources Ltd.) announced plans to increase TiO_2 pigment capacity at the Kwinana, Western Australia, plant to 150,000 t/yr from 110,000 t/yr. The expansion was expected to supplement TiO_2 supplied to Asian markets and was scheduled to be completed in 2009 (Tiwest, 2007).

Canada.—Titanium Corp. Inc. continued to pursue the recovery of heavy minerals from the Athabasca oil sands tailings in Alberta. In 2007, Titanium Corp. completed a program of process design, testing, and pilot studies, and concluded that it would be possible to recover bitumen as well as heavy minerals from oil sands tailings. In 2008, the company planned to develop integrated processes for bitumen and mineral recovery (Titanium Corp. Inc., 2008, p. 2–3).

China.—China's economic growth continued the escalation in the production and consumption of titanium minerals, pigment, and metal. In July, the Government of China eliminated a 13% tax rebate on exports of TiO_2 pigment. The elimination of the rebate was expected to ease export growth (Industrial Minerals, 2007).

Japan.—Production of titanium sponge was 38,500 t, a 4% increase compared with that in 2006. Increased sponge production combined with higher imports of titanium sponge allowed Japanese mill product shipments to increase 10% compared with those in 2006; Japan's TiO_2 pigment production in 2007 was 245,000 t, a 3% increase compared with that in 2006; however, domestic shipments decreased 3% owing to lower demand by paint producers (Roskill's Letters From Japan, 2008a, b).

Toho Titanium Co., Ltd. (Chigasaki) increased titanium sponge capacity at its Chigasaki operation to 16,000 t/yr from 15,000 t/yr. Toho also planned to construct a new 12,000-t/yr sponge plant at Kita-Kyushu City, which was scheduled to begin production by 2010 and reach full production capacity by 2011 (Toho Titanium Co. Ltd., 2007).

Because of increased demand, Sumitomo Titanium Corp. announced plans to increase its sponge capacity to 38,000 t/yr from 24,000 t/yr. The company was also raising high-purity titanium production capacity and considering additional capacity for titanium ingot production. As of October 1, Sumitomo Titanium Corp. changed its name to OSAKA Titanium Technologies Co., Ltd. (Sumitomo Titanium Corp., 2007, p. 5–6).

Kenya.—Jinchuan Group Ltd., based in Gansu, China, acquired a 20% interest in Tiomin Resources Inc.'s Kwale mineral sands project with an option to increase its interest to 30%. In 2007, the two companies were exploring ways to jointly develop the Kwale project. Tiomin had planned to produce 40,000 t/yr of zircon from the deposit until declaring force majeure in 2006 (Tiomin Resources Inc., 2007).

Madagascar.—Production at QIT Madagascar Minerals SA (QMM) mineral sands project was expected to begin by the end of 2008 with a design capacity of 700,000 t/yr of ilmenite. QMM was a joint venture between Rio Tinto plc and the Government of Madagascar. Rio Tinto planned to export the 60% grade ilmenite to its slag operation at Sorel, Quebec, Canada (Rio Tinto Plc., 2008, p. 8.)

Mozambique.—In December, Kenmare Resources plc. announced the first shipment of ilmenite from its Moma mineral sands operation. Production capacity from the mine was originally targeted for 701,000 t/yr of ilmenite, 60,000 t/yr of zircon, and 17,000 t/yr of rutile; however, Kenmare hoped to raise overall capacity to 1.2 Mt/yr of heavy-mineral concentrates by the end of 2009 (Kenmare Resources plc., 2008, p. 10).

Russia.—VSMPO-AVISMA Corp. acquired 20% interest in carnallite producer OJSC Kamskaya Mining Co. Carnallite is a mineral source of magnesium. The acquisition was expected to help support VSMPO-AVIMA's magnesium metal production, which is used in part to produce titanium sponge. In 2007, VSMPO-AVISMA increased its production of titanium sponge to 34,200 t/yr, a 6% increase compared with that in 2006 (Interfax—Metals & Mining Weekly, 2008).

In October, Aricom plc. began mining operations at the Kuranakh deposit in the Amur Region, Russia. When fully operational in 2011, the mine is expected to produce 900,000 t/yr of iron ore and 290,000 t/yr of ilmenite. Aricom also announced a project with Aluminum Corp. of China Ltd., China's leading aluminum producer, to construct a 15,000-t/yr titanium sponge plant in Heilongjiang Province, China (Aricom, plc., 2008, p. 7).

Sierra Leone.—Titanium Resources Group Ltd. (TRG) commissioned a second dredge at its Sierra Rutile mining operations. The second dredge was expected to double production capacity and increase rutile production to 200,000 t/yr. In 2007, TRG increased ilmenite (14%) and rutile (12%) production compared with those in 2006 (Titanium Resources Group Ltd., 2008, p. 1).

South Africa.—Exxaro exercised its option to acquire the Namakwa Sands operation from Anglo American plc. (Exxaro Resources Ltd., 2008, p. 54–56). In 2007, ilmenite, rutile, and slag production from the operation was 300,300 t, 24,500 t, and 151,300 t, respectively. Although rutile production decreased compared with that in 2006, production of ilmenite and slag were at record levels (Anglo American plc, 2008, p. 161).

Mineral Commodities Ltd. continued the development of its Tormin and Xolobeni mineral sands projects. At yearend, the Department of Minerals and Energy in South Africa granted Mineral Commodities Ltd. the mining right for the Tormin deposit, and the mining right for the Xolobeni deposit was pending approval. Subject to the Xolobeni mining right being granted, a bankable feasibility study was expected to be completed in 2008 (Mineral Commodities Ltd., 2008, p. 10.)

Vietnam.—The Government of Vietnam released a new mineral policy plan regarding the development of heavy-mineral deposits. The plan outlined a strategy of self sufficiency in TiO_2 processing including both TiO_2 pigment and slag production. The Government also released details of its resource and reserve estimates. Total ilmenite resources in Vietnam were reported to be 35 Mt with 1.6 Mt of proven reserves (Mineral Sands Report, 2007).

Outlook

For the foreseeable future, the market for titanium minerals will be determined by the production of TiO_2 pigment. Unless new mines are developed, the United States heavy reliance on imports of titanium mineral concentrates was likely to increase as existing mines are depleted within the next 5 to 10 years.

During the next decade, global demand growth for TiO_2 was expected to continue to increase at an average rate of about 3% annually. Higher than average growth was expected in the Asia region. China in particular was expected to lead world growth in production and consumption. However, the proliferation of small TiO_2 sulfate-route TiO_2 pigment plants in China was expected to recede as environmental concerns rise. TiO_2 production capacity in China was expected to double, reaching 1 Mt/yr by the end of the decade. During the next several years, prices for TiO_2 pigment were expected to rise because of increasing costs for chlorine, coke, caustic soda, and energy.

Growth in aerospace, defense, and industrial uses will strongly influence demand for titanium metal for the foreseeable future. In the near term (2 to 3 years), titanium sponge capacity was expected to increase significantly through the expansion of existing facilities and the addition of new operations. Based on announced capacity expansion plans, by 2015, domestic and global sponge capacities were expected to reach 43,000 t/yr and 350,000 t/yr, respectively. However, global economic conditions may delay a number of these expansions. Government and private industry programs were working to commercialize lower cost methods of producing titanium metal. At least one of these methods is expected to reach commercialization during the next few years.

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GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Recycling—Metals. Ch. in Minerals Yearbook, annual.
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TABLE 1
SALIENT TITANIUM STATISTICS[1]

		2003	2004	2005	2006	2007
United States:						
Mineral concentrate:						
Imports for consumption	metric tons	1,230,000	1,060,000	1,190,000	1,230,000	1,460,000
Consumption[2]	do.	1,790,000	1,920,000	1,720,000 e	1,870,000 e	1,950,000 e
Sponge metal:						
Imports for consumption	do.	9,590	11,900	15,800	24,400	25,900
Consumption	do.	17,100	21,200	26,100	28,400	33,700
Price, yearend[3]	dollars per pound	2.72-3.95	3.55-6.44	3.46-12.22	5.87-12.84	6.33-7.06
Titanium dioxide pigment:						
Production	metric tons	1,420,000	1,540,000	1,310,000	1,370,000 r	1,440,000
Imports for consumption	do.	240,000	264,000	341,000	288,000	221,000
Consumption, apparent	do.	1,070,000 4	1,170,000 4	1,130,000 5	1,080,000 r, 5	979,000 5
Producer price index, yearend[6]	(1982=100)	144	158	172	165	162
World, production:						
Ilmenite concentrate[7]	metric tons	5,950,000 r	6,150,000 r	6,330,000 r	7,070,000 r	7,180,000
Rutile concentrate, natural[8]	do.	384,000 r	354,000 r	374,000 r	512,000 r	594,000
Titaniferous slag[e]	do.	1,880,000	1,880,000	1,880,000	2,160,000	2,260,000

[e]Estimated. [r]Revised. do. Ditto.

[1]Data are rounded to no more than three significant digits, except prices.

[2]Excludes consumption used to produce synthetic rutile.

[3]Landed duty-paid unit based on U.S. imports for consumption.

[4]Production plus imports minus exports plus stock decrease or minus stock increase.

[5]Production plus imports minus exports. Excludes stock changes.

[6]Source: U.S. Department of Labor, Bureau of Labor Statistics.

[7]Includes U.S. production of ilmenite, leucoxene, and rutile rounded to one significant digit to avoid disclosing company proprietary data.

[8]U.S. production of rutile included with ilmenite to avoid disclosing company proprietary data.

TABLE 2

U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2007[1, 2]

(Metric tons per year)

Company	Plant location	Yearend capacity[e]	
		Sponge	Ingot[3]
Alcoa Howmet	Whitehall, MI	--	3,200
Allegheny Technologies Inc.	Albany, OR	7,300	10,900
Do.	Monroe, NC	--	14,100
Do.	Richland, WA	--	10,000
Alloy Works LLC	Greensboro, NC	--	1,800
Honeywell Electronic Materials Inc.	Salt Lake City, UT	500	--
Perryman Co.	Houston, PA	--	1,800
RTI International Metals, Inc.	Niles, OH	--	13,600
Titanium Metals Corp.	Henderson, NV	12,600	12,300
Do.	Morgantown, PA	--	20,000
Do.	Vallejo, CA	--	800
Total		20,400	88,500

[e]Estimated. Do. Ditto. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Estimated operating capacity based on 7-day-per-week full production.

[3]Includes electron-beam, plasma, and vacuum-arc-remelting capacity.

TABLE 3

COMPONENTS OF U.S. TITANIUM METAL SUPPLY AND DEMAND[1]

(Metric tons)

Component	2006	2007
Production:		
Ingot	53,100	59,200
Mill products	36,100	38,200
Exports:		
Waste and scrap	10,800	9,510
Sponge	1,380	2,000
Other unwrought	3,030	3,270
Wrought products and castings	13,300 r	15,500
Total	28,500 r	30,300
Imports:		
Waste and scrap	12,800	12,200
Sponge	24,400	25,900
Other unwrought	4,810	2,610
Wrought products and castings	5,360	5,350
Total	47,400	46,100
Stocks, industry, yearend:		
Sponge	8,240	7,820
Scrap	8,940	12,600
Ingot	4,330	5,150
Consumption, reported:		
Sponge	28,400	33,700
Scrap	25,000	23,800
Ingot	45,100	50,300
Shipments:		
Ingot	16,800 r	16,000
Mill products (net shipments):		
Forging and extrusion billet	11,800	12,400
Plate, sheet, strip	12,200	14,700
Rod, bar, fastener stock, wire	5,650	5,350
Other[2]	629	696
Total	30,200	33,200
Castings (shipments)	744	1,760
Receipts, scrap:		
Home	13,500	12,300
Purchased	19,400	18,800

rRevised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Data for pipe, tube, and other have been combined to avoid disclosing company proprietary data.

TABLE 4

U.S. PRODUCERS OF TITANIUM DIOXIDE PIGMENT IN 2007[1, 2, 3]

(Metric tons per year)

Company	Plant location	Yearend capacity[4]
Du Pont Titanium Technologies	De Lisle, MS	340,000
Do.	Edgemoor, DE	154,000
Do.	New Johnsonville, TN	380,000
Louisiana Pigment Co. L.P.	Lake Charles, LA	146,000
Millennium Inorganic Chemicals Inc.	Ashtabula, OH	220,000
Do.	Baltimore, MD	50,000
Tronox Inc.	Hamilton, MS	225,000
Do.	Savannah, GA	110,000
Total		1,630,000

Do. Ditto.

[1]Estimated operating capacity based on 7-day-per-week full production.

[2]Table does not include TOR Minerals International, Inc.'s Corpus Christi, TX, production capacity of about 26,400 metric tons per year of buff TiO_2 pigment that is produced by refining and fine grinding of synthetic rutile.

[3]Data are rounded to no more than three significant digits; may not add to total shown.

[4]All plants use the chloride process to manufacture TiO_2 pigment.

TABLE 5

COMPONENTS OF U.S. TITANIUM DIOXIDE PIGMENT SUPPLY AND DEMAND[1]

		2006		2007	
		Gross weight	TiO_2 content	Gross weight	TiO_2 content
Production[2]	metric tons	1,370,000 r	1,220,000 r, e	1,440,000	1,360,000 e
Shipments:[3]					
Quantity	do.	1,400,000	1,320,000 e	1,480,000	1,400,000 e
Value	thousands	$3,020,000	XX	$2,760,000	XX
Exports	metric tons	581,000	546,000 e	682,000	641,000 e
Imports for consumption	do.	288,000	271,000 e	221,000	208,000 e
Consumption, apparent[e, 4]	do.	1,080,000 r	946,000 r	979,000	925,000

eEstimated. rRevised. do. Ditto. XX Not applicable.

[1]Data are rounded to no more than three significant digits.

[2]Excludes production of buff pigment.

[3]Includes interplant transfers.

[4]Production plus imports minus exports. Excludes stock changes.

Sources: U.S. Census Bureau and U.S. Geological Survey.

TABLE 6

ESTIMATED U.S. CONSUMPTION OF TITANIUM CONCENTRATE[1, 2]

(Metric tons)

	2006		2007	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Pigment	1,800,000	NA	1,860,000	NA
Miscellaneous[3]	72,000	NA	85,000	NA
Total	1,870,000	1,510,000 r	1,950,000	1,600,000

rRevised. NA Not available.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes a mixed product containing altered ilmenite, leucoxene, and rutile.

[3]Includes alloys, carbide, ceramics, chemicals, glass fibers, titanium metal, and welding-rod coatings and fluxes.

TABLE 7

U.S. CONSUMPTION OF TITANIUM IN STEEL AND OTHER ALLOYS[1, 2]

(Metric tons)

	2006	2007
Steel:		
Carbon steel	4,630 r	6,460
Stainless and heat-resisting steel	3,270	3,330
Other alloy steel[3]	568	740
Total steel	8,470 r	10,500
Cast irons	15	14
Superalloys	1,300	1,200
Alloys, other than above	1,640 r	1,390
Miscellaneous and unspecified	38 r	41
Grand total	11,500 r	13,200

rRevised.

[1]Includes ferrotitanium, scrap, sponge, and other titanium additives.

[2]Data are rounded to no more than three significant digits; may not add to totals shown.

[3]Includes high-strength low-alloy and tool steel.

TABLE 8

U.S. DISTRIBUTION OF TITANIUM PIGMENT SHIPMENTS, TITANIUM DIOXIDE CONTENT, BY INDUSTRY[1]

(Percent)

Industry	2006	2007
Paint, varnish, lacquer	57.1	59.1
Paper	12.6	11.6
Plastics and rubber	26.3	23.8
Other[2]	4.0	5.5
Total	100.0	100.0

[1]Excludes exports.

[2]Includes agricultural, building materials, ceramics, coated fabrics and textiles, cosmetics, food, paper, and printing ink. Also includes shipments to distributors.

TABLE 9
YEAREND PRICES OF TITANIUM PRODUCTS

		2006	2007
Concentrate:			
Ilmenite, free on board (f.o.b.) Australian ports[1]	dollars per metric ton	75-85	75-85
Rutile, bagged, f.o.b. Australian ports[1]	do.	570-700	650-700
Rutile, bulk, f.o.b. Australian ports[1]	do.	450-500	475-500
Titaniferous slag, import, 80% to 95% TiO_2[2]	do.	402-454	418-457
Metal:			
Sponge import[2]	dollars per pound	5.87-12.84	6.33-7.06
Scrap, turnings, unproccessed[3]	do.	4.00-4.40	2.00-2.05
Ferrotitanium, 70% Ti[3]	do.	6.79-7.00	3.80-3.85
Mill products[4]	producer price index	300	277
Titanium dioxide pigment[4]	do.	165	162

do. Ditto.

[1]Source: Industral Minerals.

[2]Landed duty-paid unit value based on U.S. imports for consumption.

[3]Source: Platts Metals Week.

[4]1982=100. Source: U.S. Department of Labor, Bureau of Labor Statistics.

TABLE 10
U.S. EXPORTS OF TITANIUM BY CLASS[1]

		2006		2007	
Class	HTS[2]	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Metal:					
Scrap	8108.30.0000	10,800	$110,000	9,510	$67,300
Unwrought:					
Sponge	8108.20.0010	1,380	15,600	2,000	20,300
Ingot	8108.20.0030	2,070	41,300	2,270	44,200
Other	8108.20.0090	956	22,300	1,000	31,800
Wrought:					
Billet	8108.90.6010	1,200	64,500	2,730	149,000
Bloom, sheet bar, slab	8108.90.6020	532	13,400	1,280	38,600
Bar, rod, profile, wire	8108.90.6031	3,670	237,000	2,840	202,000
Other	8108.90.8000	7,900	528,000	8,670	638,000
Total		28,500	1,030,000	30,300	1,190,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	2,320	12,100	2,120	11,500
Ores and concentrates	2614.00.0000	32,800	11,800	9,730	5,140
Pigment:					
80% or more titanium dioxide pigment	3206.11.0000	513,000	911,000	564,000	1,020,000
Other titanium dioxide pigment	3206.19.0000	57,100	147,000	111,000	241,000
Unfinished titanium dioxide[3]	2823.00.0000	10,800	24,700	7,200	15,900
Total		581,000	1,080,000	682,000	1,280,000

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

[3]Unmixed and not surface treated.

Source: U.S. Census Bureau.

TABLE 11

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM CONCENTRATE, BY COUNTRY[1]

Concentrate and country	HTS[2]	2006 Quantity (metric tons)	2006 Value (thousands)	2007 Quantity (metric tons)	2007 Value (thousands)
Ilmenite:	2614.00.6020				
Australia		127,000	$14,200	228,000	$22,900
Ukraine		60,100	5,890	--	--
Other		--	--	18,000	3,940
Total		187,000	20,100	246,000	26,900
Titaniferous slag:	2620.99.5000				
Canada		159,000	68,200	193,000	84,100
South Africa		512,000	199,000	475,000	188,000
Other[3]		22,000	8,990	80,700	29,900
Total		693,000	276,000	749,000	302,000
Rutile, natural:	2614.00.6040				
Australia		60,100	28,100	145,000	67,600
Sierra Leone		7,500	3,600	27,000	13,200
South Africa		136,000	61,400	170,000	77,100
Ukraine		5,530	2,610	1,880	1,800
Other[3]		41,800 r	18,800 r	34,600	17,700
Total		251,000	114,000	379,000	177,000
Rutile, synthetic:	2614.00.3000				
Australia		73,000	33,400	64,700	15,400
Malaysia		9,060	4,300	5,110	2,430
Other[3]		22,300	10,000	15,000	6,040
Total		104,000	47,800	84,800	23,900
Titaniferous iron ore, Canada[4]	2614.00.6020	49,800	3,240	72	8

rRevised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

[3]All or part of these data have been referred to the U.S. Census Bureau for verification.

[4]Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel-furnace flux. Titaniferous iron ore from Canada is classified as ilmenite under the HTS.

Source: U.S. Census Bureau; data adjusted by the U.S. Geological Survey.

TABLE 12

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY[1]

Class and country	HTS[2]	2006 Quantity (metric tons)	2006 Value (thousands)	2007 Quantity (metric tons)	2007 Value (thousands)
Waste and scrap:	8108.30.0000				
Canada		664	$6,380	908	$5,330
China		596	10,800	275	3,510
France		1,350	21,300	1,670	17,900
Germany		2,070	41,500	1,430	25,800
Israel		325	6,450	231	2,480
Italy		400	4,970	342	4,050
Japan		2,320	33,400	2,210	18,800
Mexico		218	1,740	245	1,160
Russia		586	13,100	472	9,950
Taiwan		657	11,900	953	13,100
United Kingdom		2,160	24,100	2,700	22,500
Other		1,470 r	24,500 r	798	8,670
Total		12,800	200,000	12,200	133,000
Unwrought:					
Sponge:	8108.20.0010				
China		579	11,800	2,220	36,000
Japan		8,070	86,800	8,250	118,000
Kazakhstan e		12,400	83,700	13,800	142,000
Russia		1,570	27,800	822	11,800
Ukraine		1,650	40,100	703	11,100
Other		118 r	1,510 r	151	1,970
Total		24,400	252,000	25,900	321,000
Ingot:	8108.20.0030				
Germany		555	19,400	884	30,000
Russia		2,430	34,200	1,300	21,800
Other		159 r	5,170 r	78	1,720
Total		3,140	58,800	2,270	53,500
Powder:	8108.20.0015				
China		99	3,030	218	6,310
Ireland		36	68	--	--
Japan		14	1,470	24	2,200
Other		3 r	596 r	4	1,280
Total		152	5,170	246	9,790
Other:	8108.20.0091				
France		367	6,410	19	587
Germany		114	2,590	34	176
Japan		479	12,600	--	--
Taiwan		138	2,230	17	214
United Kingdom		338	10,600	5	146
Other		82 r	1,280 r	24	505
Total		1,520	35,600	101	1,630
Wrought products and castings:[3]	8108.90.3030, 8108.90.3060, 8108.90.6010, 8108.90.6020, 8108.90.6031, 8108.90.6045, 8108.90.6060, 8108.90.6075				
Canada		181	9,470	138	8,710
China		304	15,900	920	38,400
Japan		487	22,500	372	22,600
Russia		3,820	91,500	3,290	105,000
United Kingdom		184	11,400	176	14,300
Other		386 r	30,100 r	449	39,500
Total		5,360	181,000	5,350	229,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	7,080	63,400	7,620	35,300

eEstimated. rRevised. -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 12—Continued

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY[1]

[2]Harmonized Tariff Schedule of the United States.

[3]Includes bar, billet, bloom, castings, foil, pipe, plate, profile, rod, sheet, sheet bar, slab, strip, tube, wire, and other.

Source: U.S. Census Bureau.

TABLE 13

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM PIGMENT, BY COUNTRY[1]

		2006		2007	
Country	HTS[2]	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
80% or more titanium dioxide pigment:	3206.11.0000				
Australia		7,730	$14,800	2,360	$4,590
Belgium		9,060	17,200	4,920	8,950
Canada		76,200	157,000	81,100	161,000
China		26,900	37,600	12,900	19,100
Finland		15,100	30,100	12,000	24,200
Germany		17,700	38,100	5,960	13,400
Italy		6,880	10,900	6,080	10,200
Japan		4,240	12,100	3,440	10,200
Netherlands		5,110	10,900	3,790	7,520
Spain		12,200	19,600	10,500	17,200
United Kingdom		6,420	11,500	3,970	6,820
Other		18,900 r	33,600 r	20,100	33,800
Total		206,000	393,000	167,000	317,000
Other titanium dioxide:	3206.19.0000				
Canada		1,870	7,610	2,340	12,400
China		1,270	2,490	825	2,440
Finland		269	2,730	184	2,240
France		52	191	275	634
Germany		762	2,270	688	2,410
India		208	452	61	119
Japan		284	4,260	698	5,780
Korea, Republic of		30	172	920	1,690
United Kingdom		111	1,820	183	3,300
Other		568 r	1,460 r	387	1,430
Total		5,420	23,500	6,570	32,400
Unfinished titanium dioxide:[3]	2823.00.0000				
Canada		16,200	8,520	61	115
China		17,800	24,700	14,600	21,300
Czech Republic		3,610	6,420	2,730	4,990
France		13,300	25,300	4,110	9,390
Germany		6,110	12,500	6,250	13,700
India		4,680	6,020	1,500	2,060
Korea, Republic of		6,360	8,550	4,940	6,270
United Kingdom		2,460	3,290	7,080	9,580
Other		5,700 r	14,300 r	6,070	15,800
Total		76,200	110,000	47,300	83,200
Grand total		288,000	526,000	221,000	432,000

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Harmonized Tariff Schedule of the United States.

[3]Unmixed and not surface treated.

Source: U.S. Census Bureau.

TABLE 14

TITANIUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY[1, 2]

(Metric tons)

Concentrate type and country	2003	2004	2005	2006	2007
Ilmenite and leucoxene:[3, 4]					
Australia	2,063,000	1,965,000	2,080,000	2,516,000 r	2,506,000
Brazil[5]	218,000 r	242,000 r	231,000 r	231,000 r	236,000 p
China[e]	800,000	840,000	900,000	1,000,000	1,100,000
Egypt[e]	125,000	125,000	125,000	125,000	125,000
India[e]	562,000 r	621,000 r	686,000 r	690,000 r	700,000
Kazakhstan[e]	9,300	11,670	10,000	25,000	25,000
Malaysia	95,148	61,471	38,196	45,649 r	45,000 e
Mozambique	--	--	--	--	23,000
Norway[e]	840,000	860,000	860,000	850,000	850,000 e
Sierra Leone	--	--	--	13,819	15,750
Ukraine	420,500	370,000 e	375,000 e	470,000	500,000
United States[e, 6]	500,000	500,000	500,000	500,000	400,000
Vietnam[e, 7]	314,000 r	550,000 r	523,000 r	605,000 r	650,000
Total[8]	5,950,000 r	6,150,000 r	6,330,000 r	7,070,000 r	7,180,000
Rutile:[4]					
Australia	173,000	162,000	177,000	232,000 r	313,000
Brazil[5]	24,500 r	2,252 r	2,201 r	2,234 r	3,190 p
India[e]	18,000	20,000 r	20,000 r	21,000 r	21,000
Sierra Leone	--	--	--	73,802	82,530
South Africa[e]	108,000	110,000	115,000	123,000	114,000
Ukraine[e]	60,000	60,000	60,000	60,000	60,000
United States	(9)	(9)	(9)	(9)	(9)
Total	384,000 r	354,000 r	374,000 r	512,000 r	594,000
Titaniferous slag:[e, 10]					
Canada	873,000	863,000	860,000	930,000	960,000
South Africa	1,010,000	1,020,000	1,020,000	1,230,000	1,295,000
Total	1,880,000	1,880,000	1,880,000	2,160,000	2,260,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through July 10, 2008.

[3]Ilmenite is also produced in Canada and South Africa, but this output is not included here because most of it is duplicative of output reported under "Titaniferous slag," and the rest is used for purposes other than production of titanium commodities, principally steel furnace flux and heavy aggregate.

[4]Small amounts of titanium minerals were reportedly produced in various countries; information, however, is inadequate to make reliable estimates of output levels.

[5]Excludes production of unbeneficiated anatase ore.

[6]Includes rutile to avoid disclosing company proprietary data. Rounded to one significant digit.

[7]Estimate based on import statistics from trading partners (primarily China and Japan).

[8]Includes U.S. production, rounded to one significant digit, of ilmenite, leucoxene, and rutile to avoid disclosing company proprietary data.

[9]Included with ilmenite to avoid disclosing company proprietary data.

[10]Slag is also produced in Norway, Kazakhstan, and Russia, but this output is not included under "Titaniferous slag" to avoid duplicative reporting.